



U.S. Department of Energy
Energy Efficiency and Renewable Energy

DATA CENTER ENERGY EFFICIENCY TRAINING

Overview

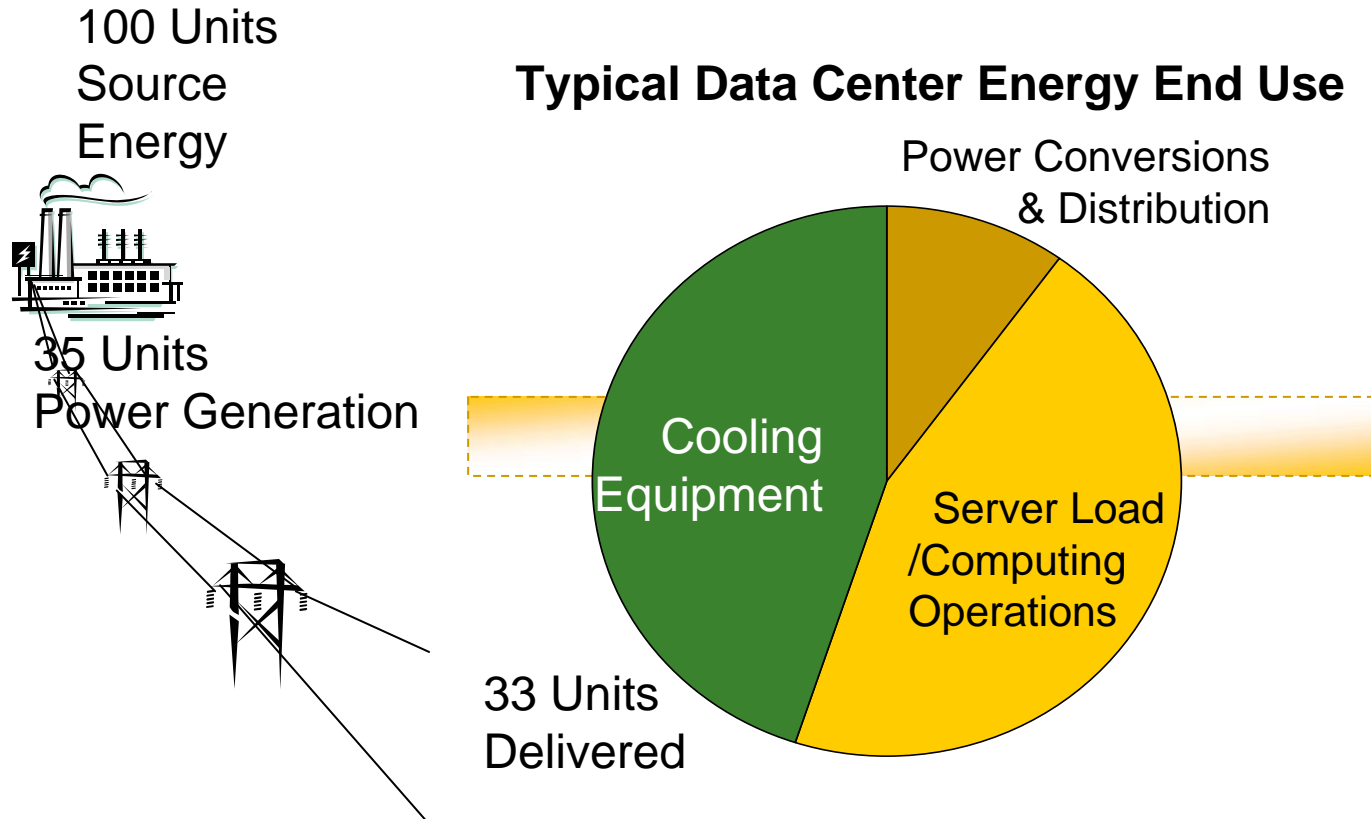


<Presenter>



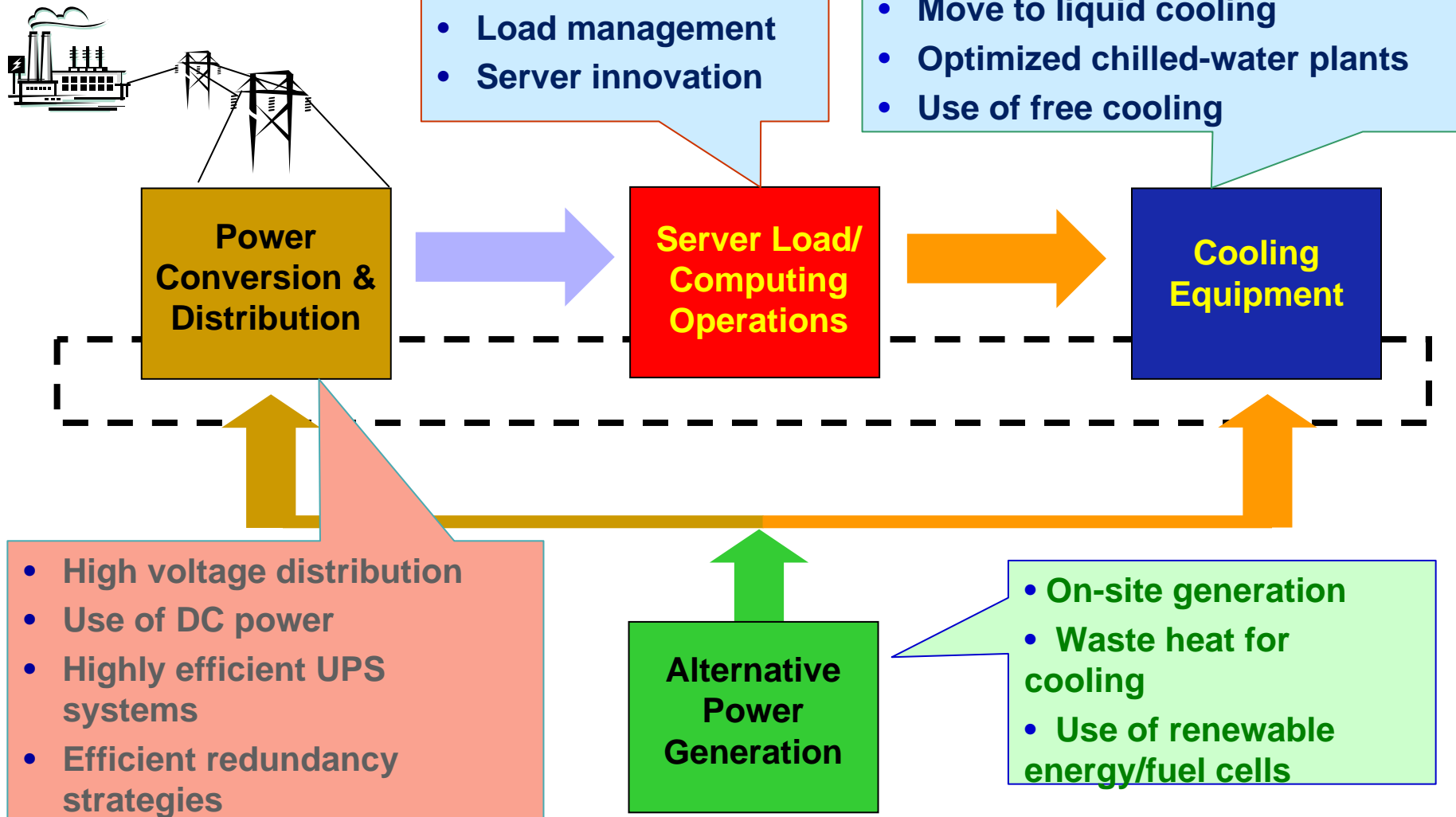
Data Center Energy Efficiency = 15% (or less)

Energy Efficiency = Useful computation / Total Source Energy





Opportunities



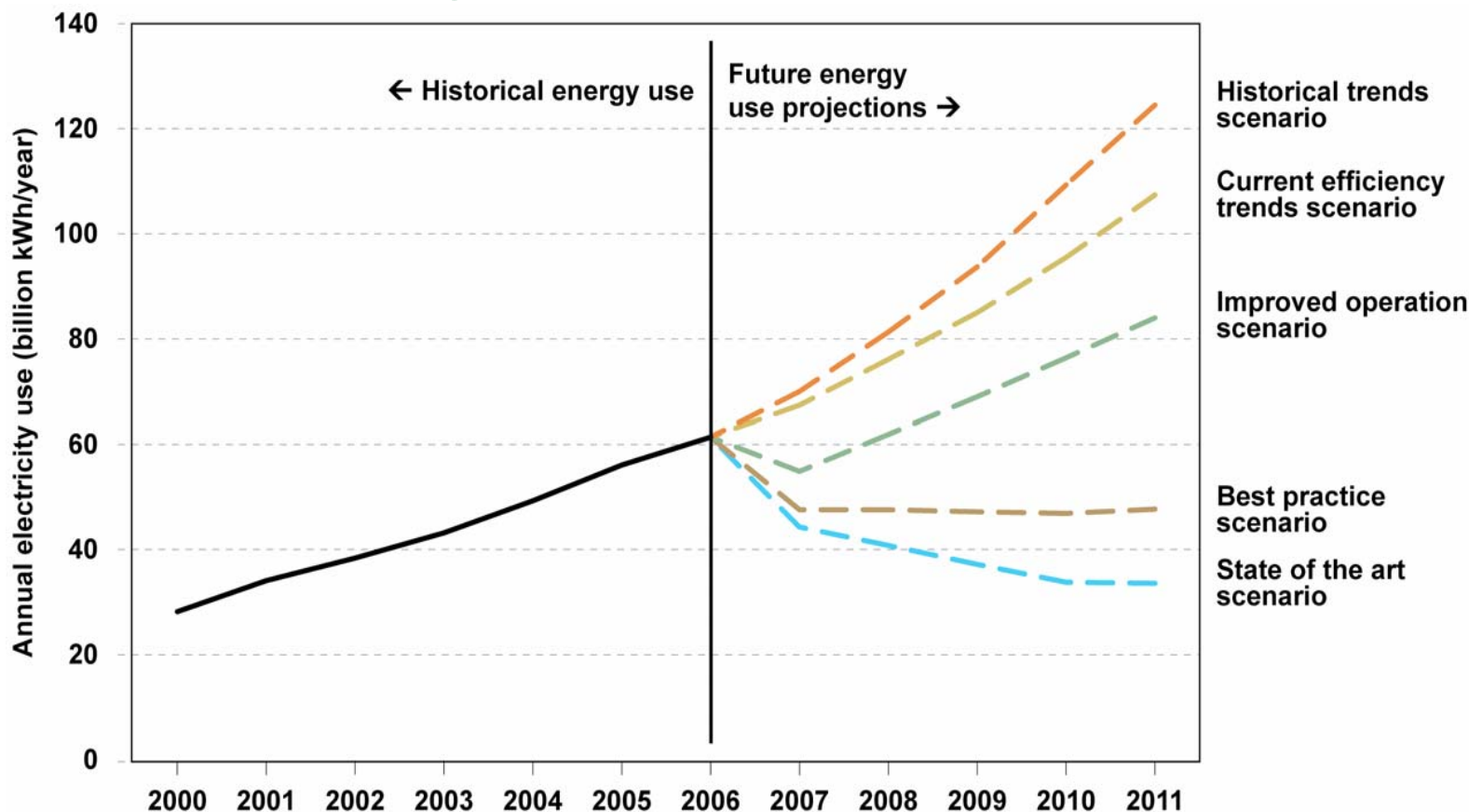


U.S. Data Center energy efficiency goal by 2011

- Industry, DOE and partners perform 1,000 Save Energy Now assessments using a common protocol and tool suite to yield savings of 5 billion kWh per year
- Industry-DOE energy efficiency campaign saves an additional 20 billion kWh per year
- Total energy savings of 25 billion kWh per year by 2011; 25% below current trends, which yields:
 - \$2 billion of electricity cost savings
 - carbon emission reduction of 5 MTCEE; equal to the emissions from 3.5 million cars
 - All the electricity consumed in the state of Utah in one year



Scenarios of Projected Energy Use from EPA Report to Congress 2007 - 2011





Data Center Definitions

- Server closet < 200 sf
- Server room < 500 sf
- Localized data center <1,000 sf
- Mid-tier data center <5,000 sf
- Enterprise data center 5,000+ sf

**Focus today's training on larger data centers—
however most principles apply to any size
center**



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Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Overview

An “instant” data center...





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Overview

Where's the data center?





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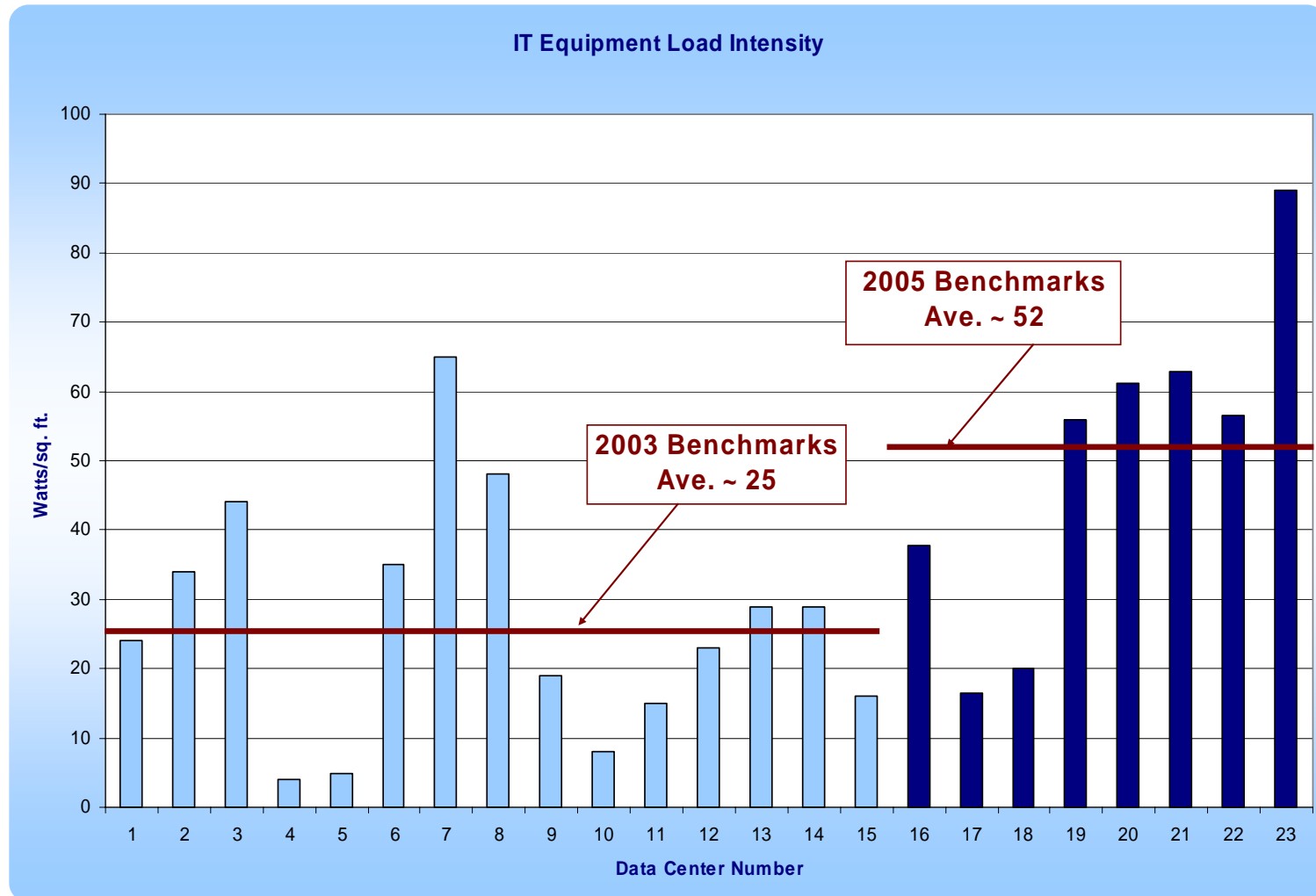
Overview

Here's the data center!





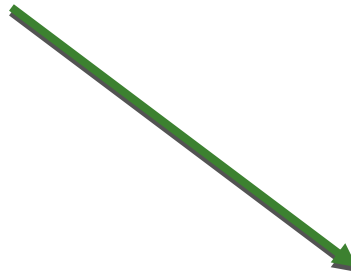
IT Equipment Load Density



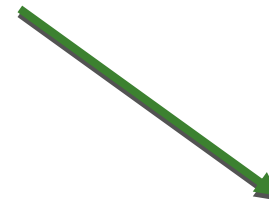


Data Center Efficiency Opportunities

**Benchmarking of over 25
centers consistently lead to
opportunities**



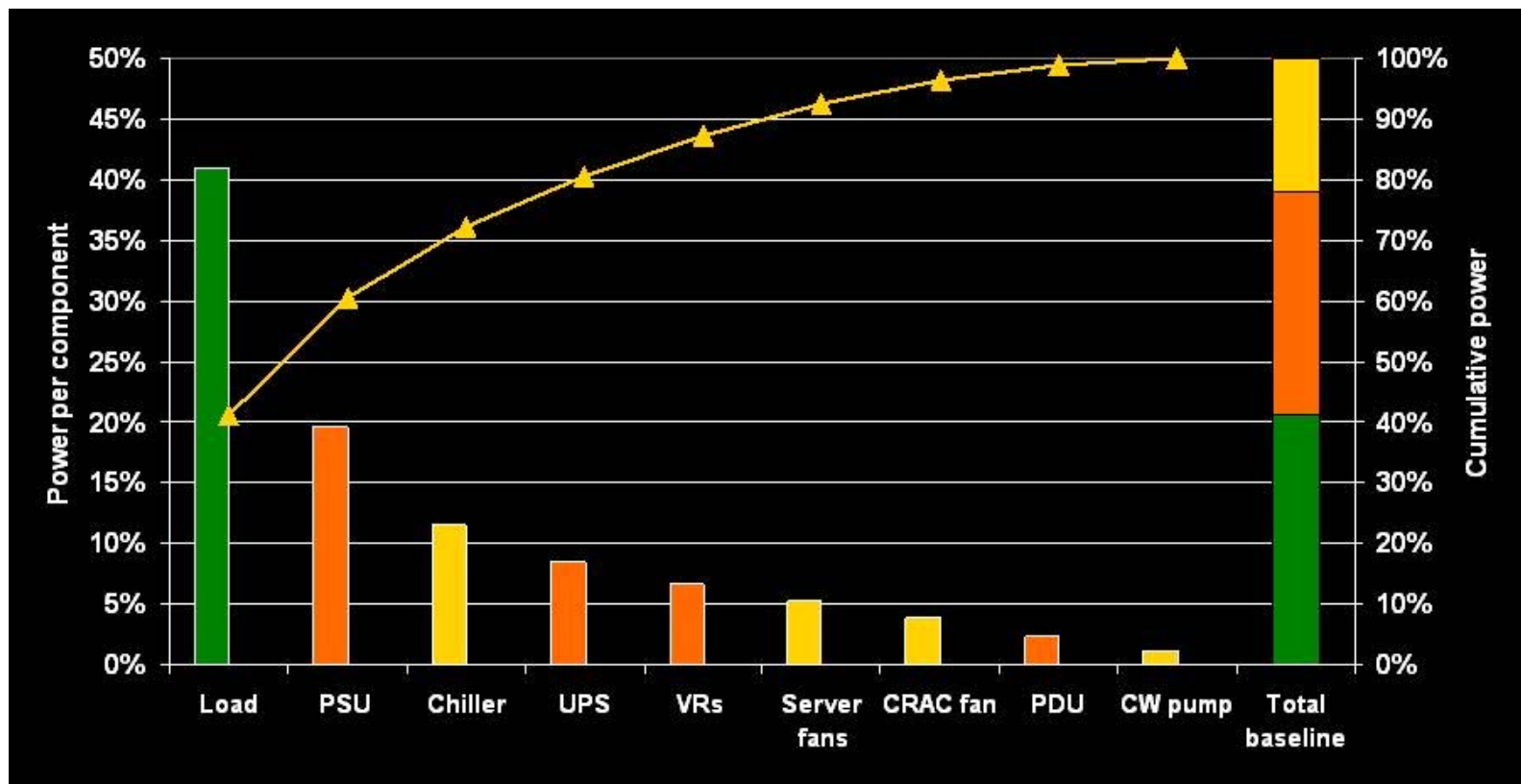
No silver bullet



Lots of silver bb's



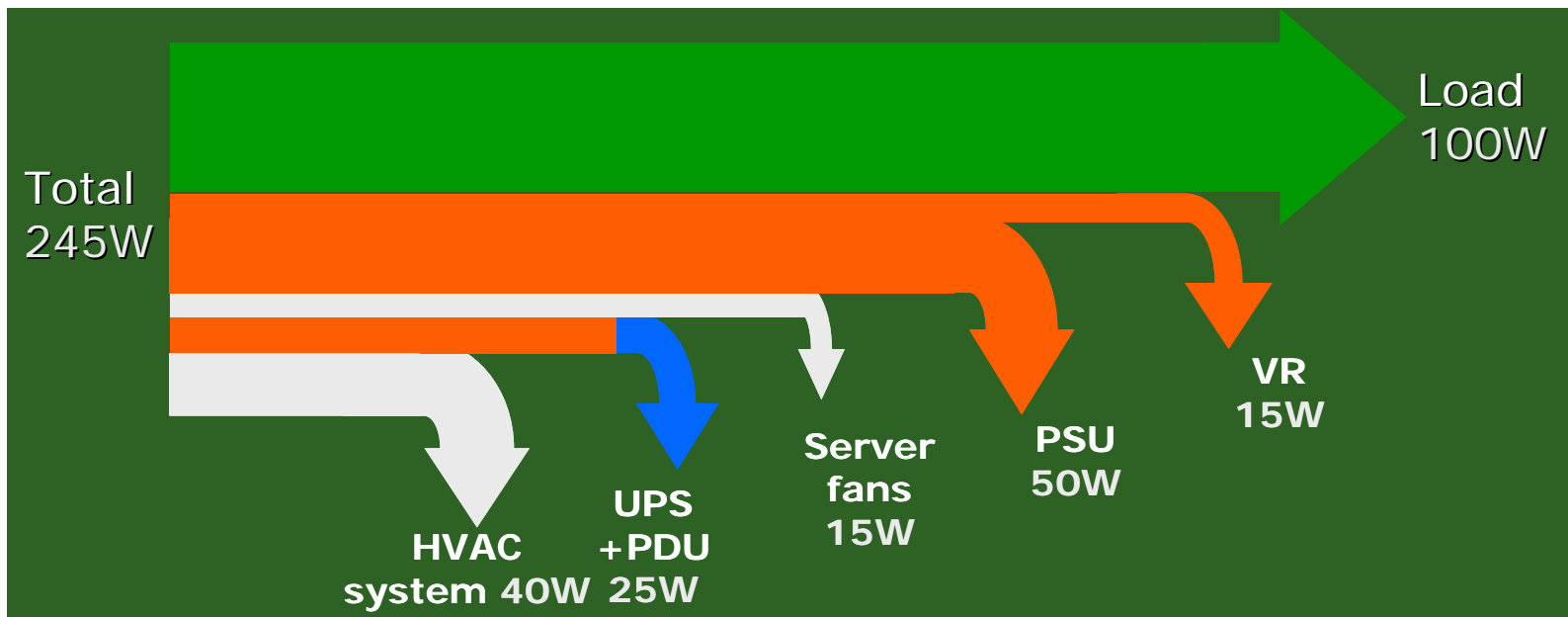
Overall Electrical Power Use in Data Centers



Courtesy of Michael Patterson, Intel Corporation



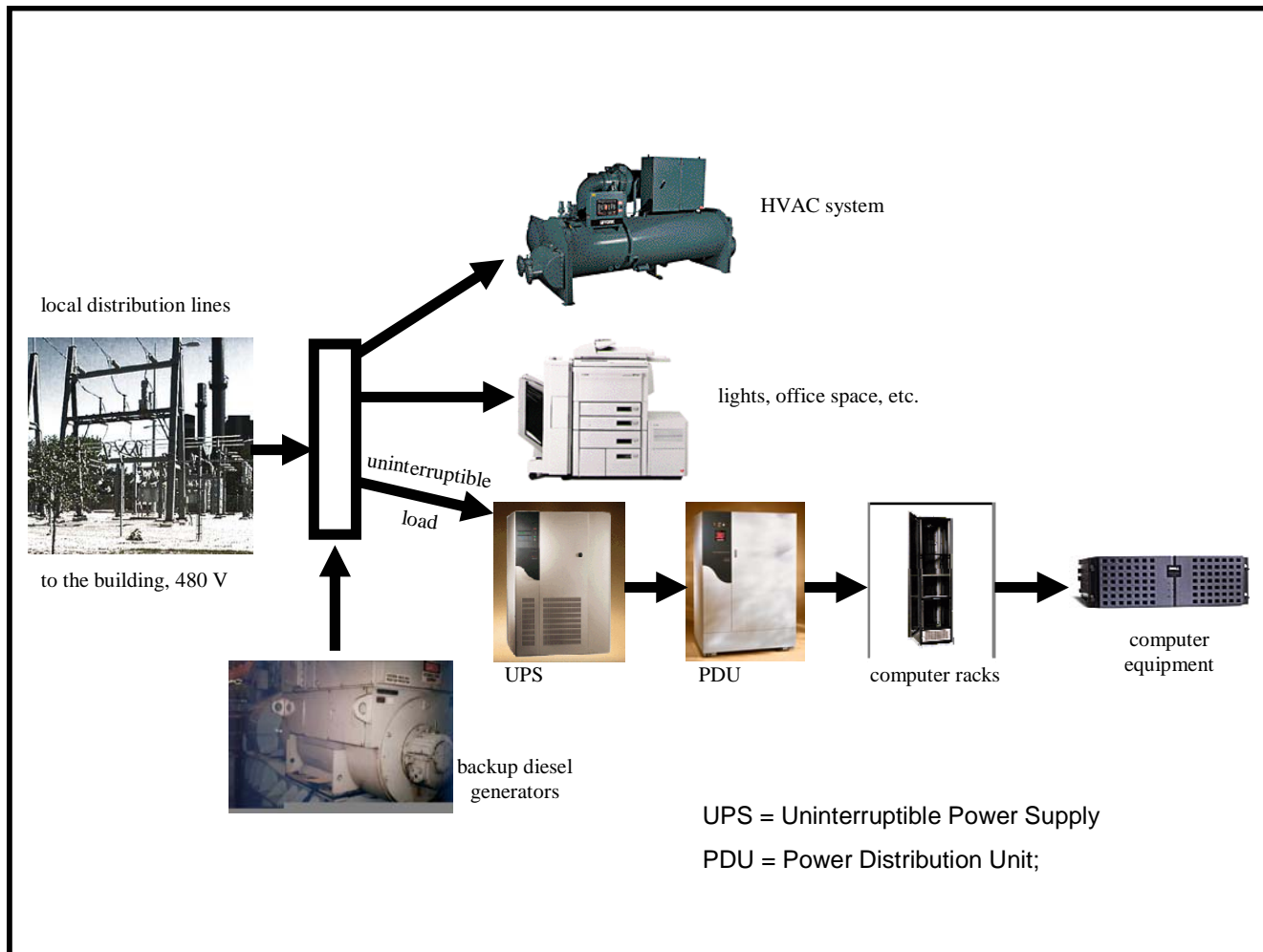
Overall power use in data centers



Courtesy of Intel Corporation



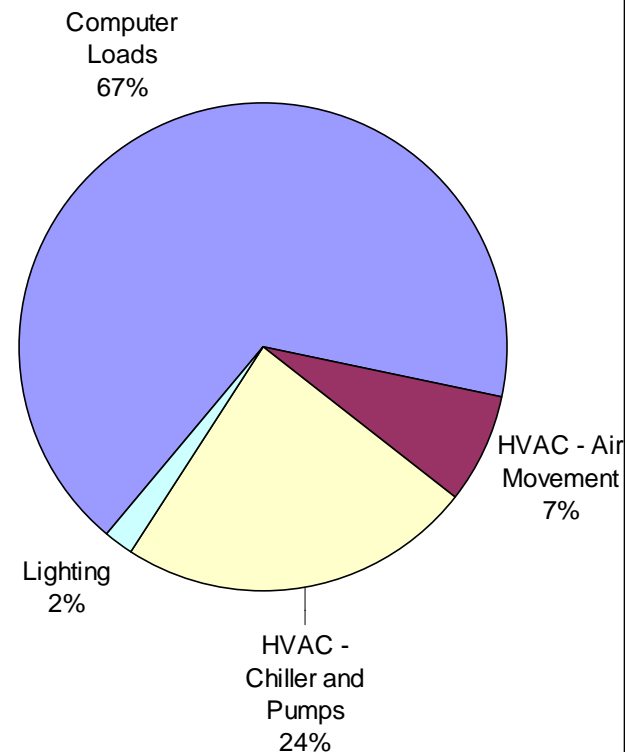
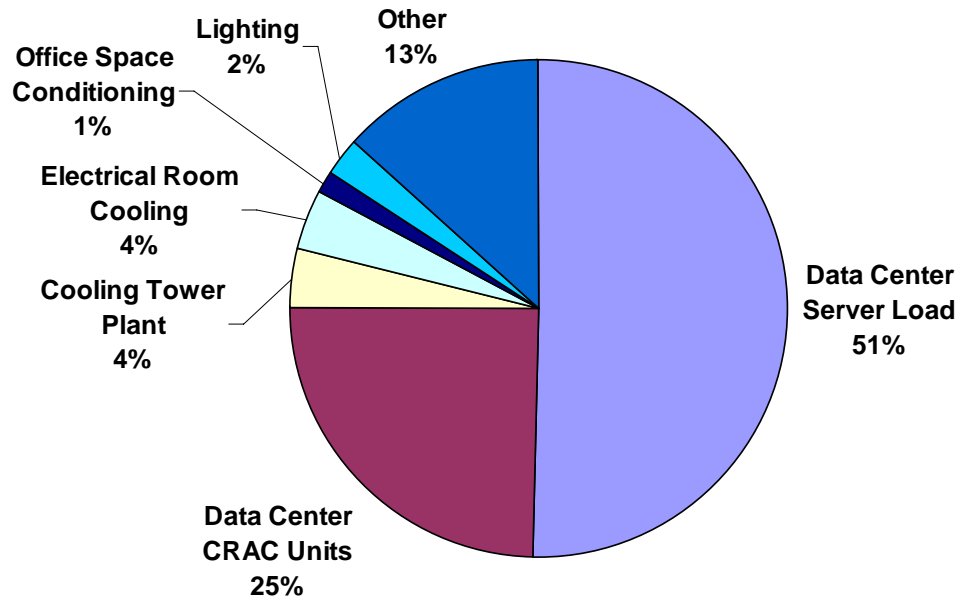
Electricity flows in data centers





Your Mileage Will Vary

The relative percentages of the energy actually doing computing vary considerably.



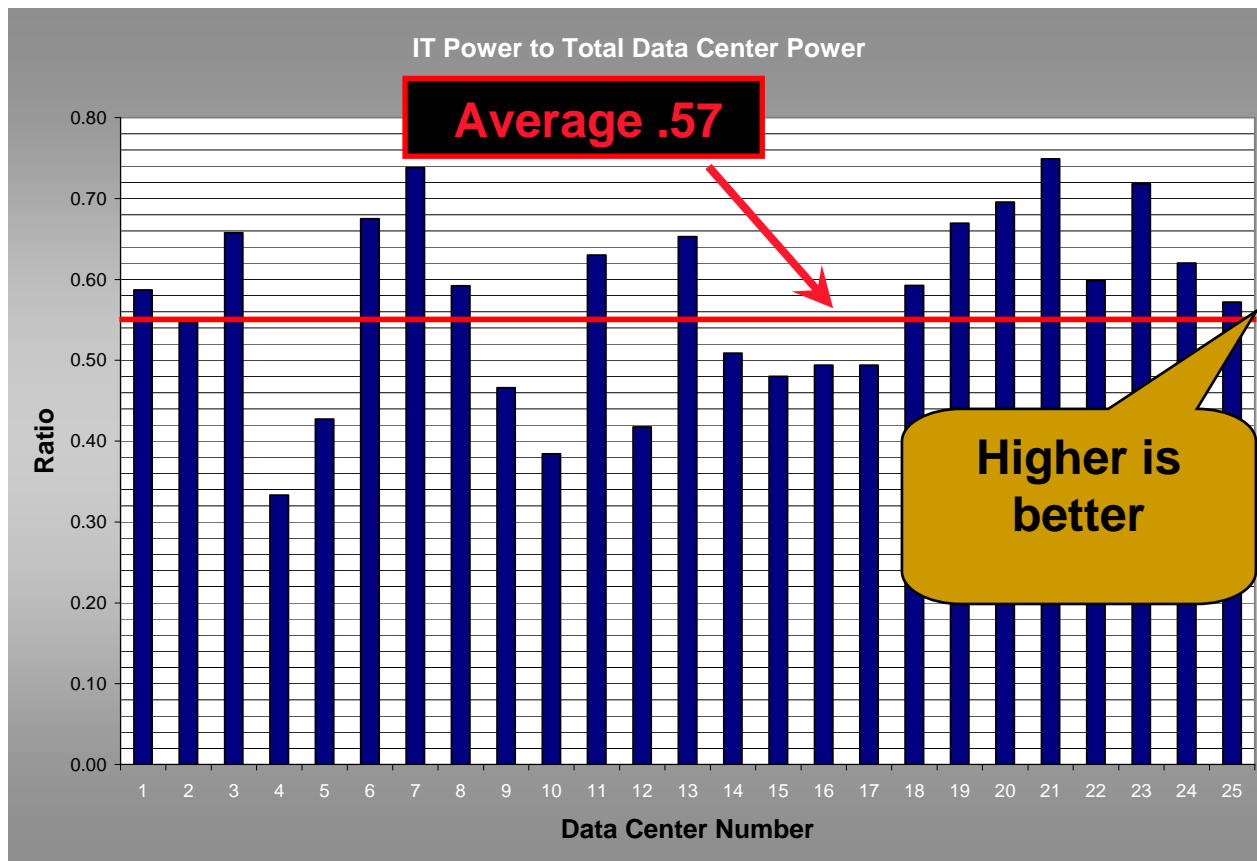


Benchmark Results Help Identify Best Practices

The ratio of IT equipment power to the total is an indicator of relative overall efficiency. Examination of individual systems and components in the centers that performed well helped to identify best practices.



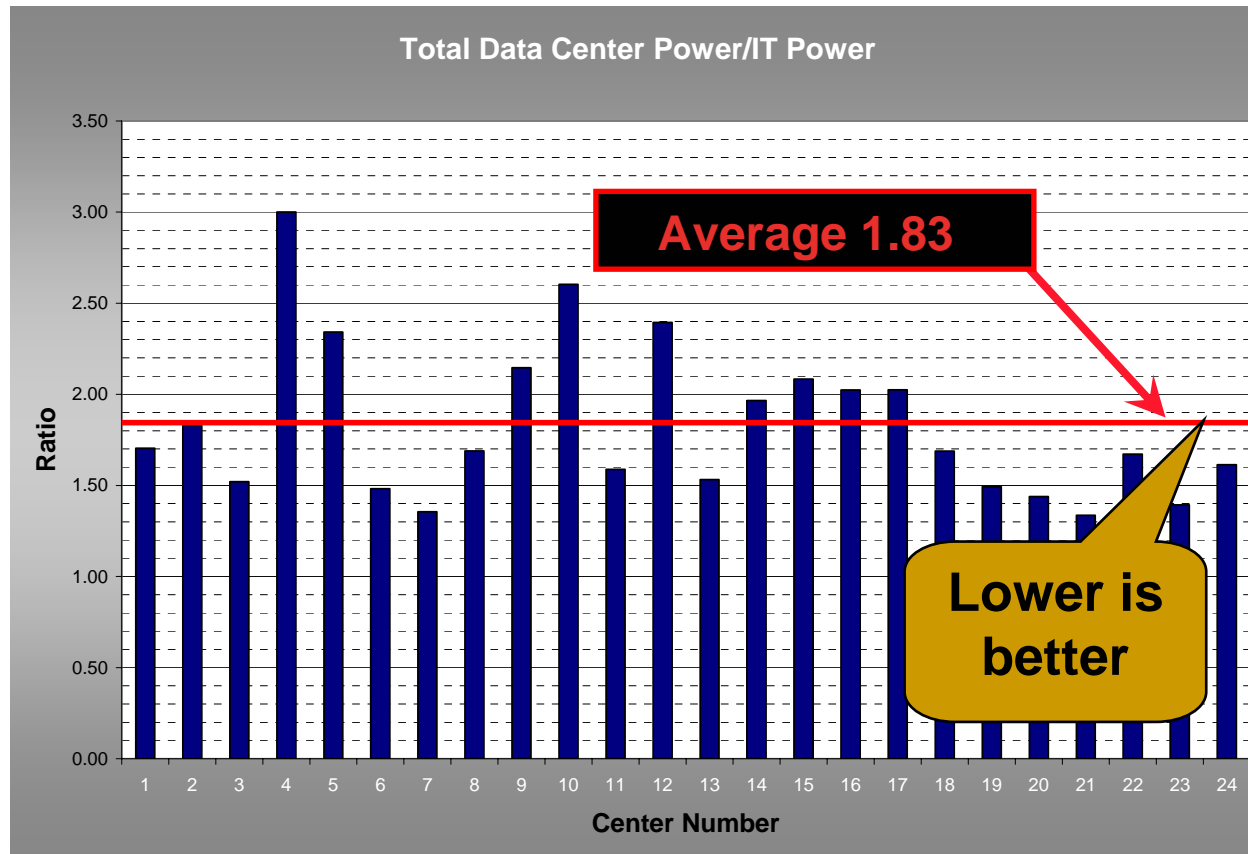
High Level Metric— Ratio of Electricity Delivered to IT Equipment



Source: LBNL Benchmarking



Alternate High Level Metric – Data Center Total / IT Equipment (PUE)

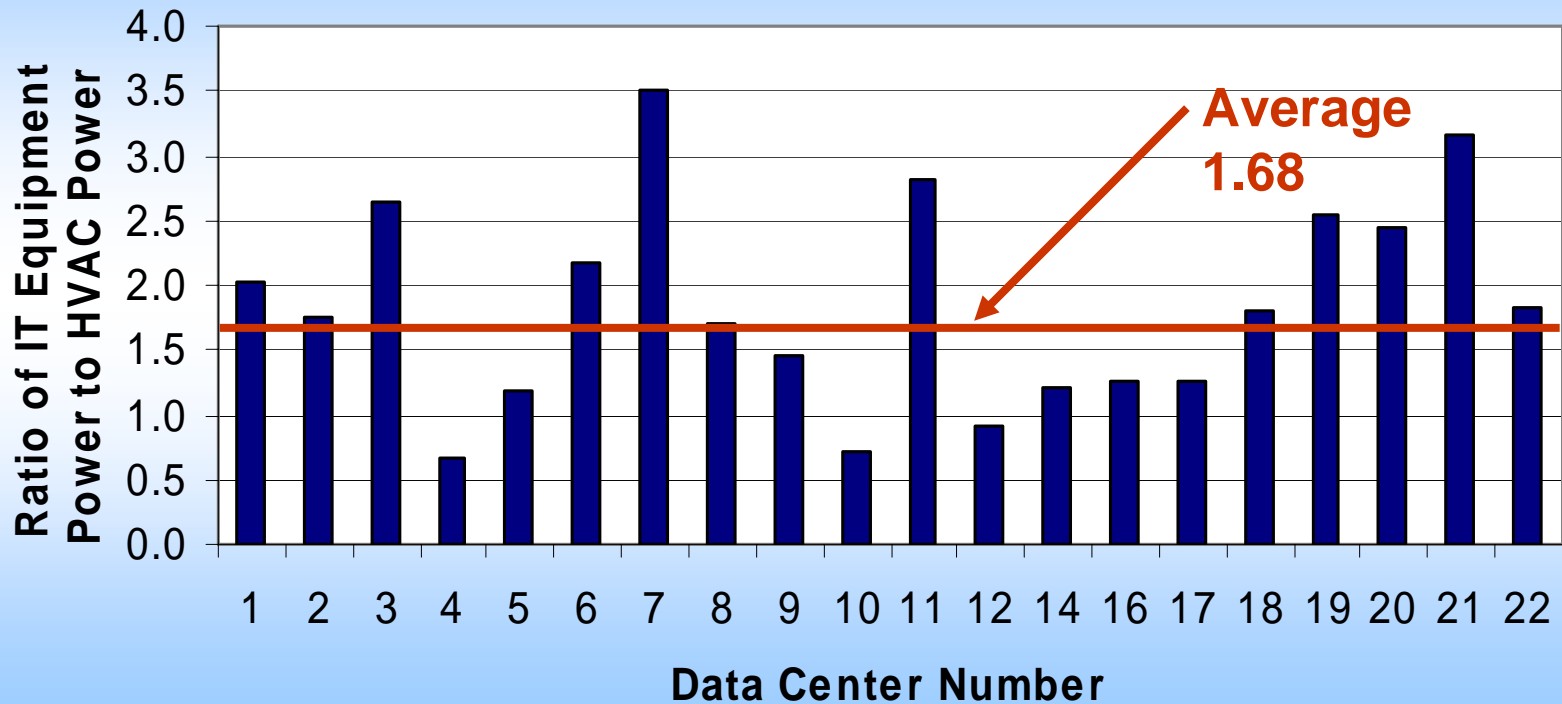


Source: LBNL Benchmarking



HVAC System Effectiveness

HVAC Effectiveness Index





Potential Savings

- Electrical bill will exceed the cost of IT equipment over its useful life
- 20-40% savings typically possible
- Aggressive strategies – better than 50% savings
- Paybacks are short – 1 to 3 years are common



The value of 1 Watt saved at the server CPU...

- = 1.25 Watts at entry to server (80% efficient power supply)
- = 1.56 Watts at entry to UPS (80% efficient power supply)
- = 2.5 Watts including cooling (1.6 PUE)
- = 21.9 kWh per year
- = \$2.19 per year (assuming \$0.10/kWh)
- = \$6 of infrastructure cost (assuming \$6/W)
- **Total Cost of Ownership (TCO) Perspective = \$12.60 (assuming three year life of server)**
- **Typical added cost of 80 plus power supply \$3 - \$5.**
- **Typical value - \$168 (assumes 15 Watts saved at power supply not CPU)**



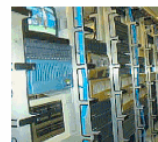
Design Guidelines for Ten Best Practices Were Developed

Guides available through PG&E's
Energy Design Resources Website

HIGH PERFORMANCE DATA CENTERS



A Design Guidelines Sourcebook
January 2006





Design Guidance is Summarized in a Web-Based Training Resource

Data Center Energy Management - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://hightech.lbl.gov/dctraining/TOP.html

mozilla.org Latest Builds

Home >

DATA CENTER ENERGY MANAGEMENT

About Benchmarking Best Practices Checklist Design Intent Documentation Economics Non-energy Benefits Case Studies Tools Emerging Technologies

- This website will give you the tools and information to capture cost-effective savings opportunities to the design of new data centers or to retrofit existing ones.
- Data center energy costs can be 100-times higher than those for typical buildings.
- Inefficiencies can hurt the bottom line, erode competitiveness, and reduce uptime.

ft²/yr

\$75 High

\$5 Low

Get Started:

Enter your annual energy cost

\$/yr

and data center size

sq ft

GO

Range of Energy Costs in Real Data Centers

For public sector and private sector users.

High-Tech Research ■ Applications Team ■ Environmental Energy Technologies Division ■ Berkeley Lab

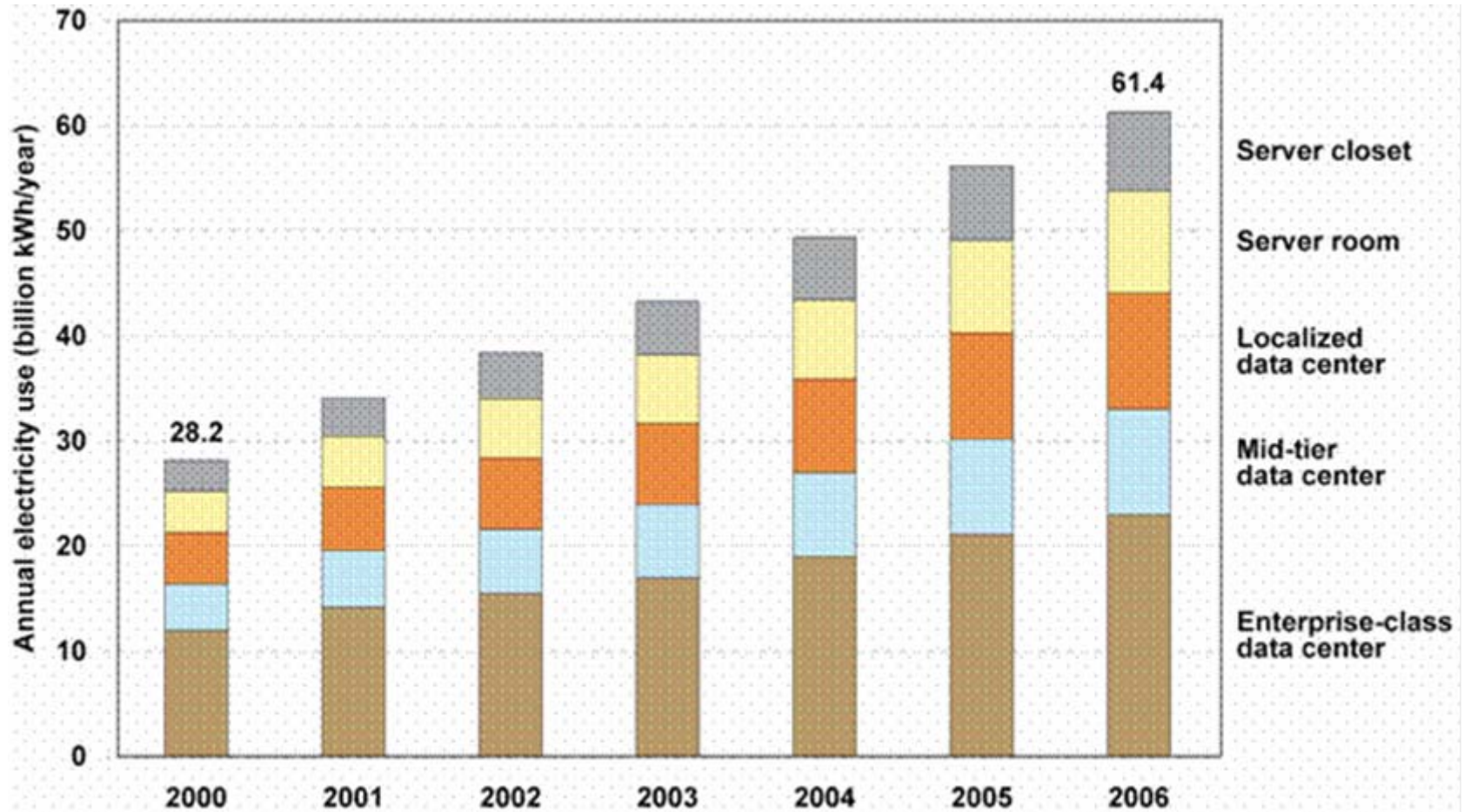
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Resources
Exercises
Credits

<http://hightech.lbl.gov/dctraining/TOP.html>



EPA report to Congress: Breakdown of Space



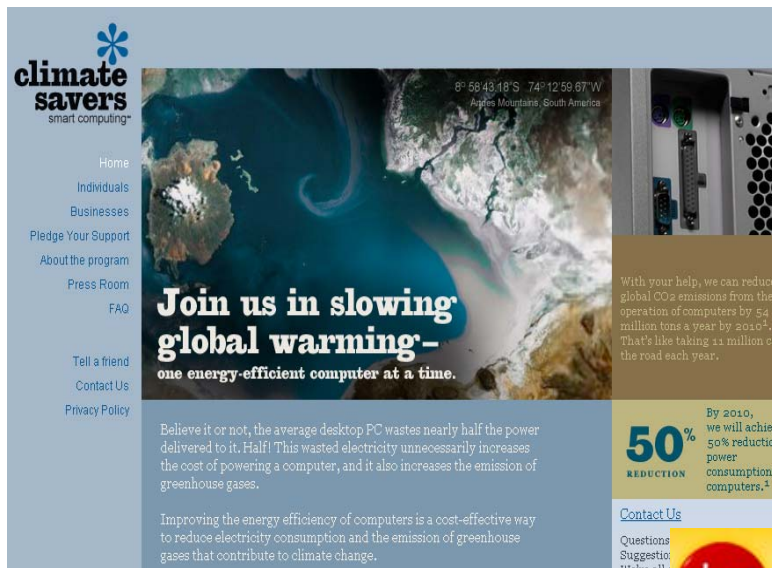


The Good News

- Industry is taking action
 - IT manufacturers
 - Infrastructure equipment manufacturers
- Industry Associations are active:
 - ASHRAE
 - Green Grid
 - Uptime Institute
 - Afcom
 - Critical Facilities Roundtable
 - 7 X 24 Exchange



IT Industry Taking Action



climate savers
smart computing™

Home
Individuals
Businesses
Pledge Your Support
About the program
Press Room
FAQ

Tell a friend
Contact Us
Privacy Policy

Join us in slowing global warming—
one energy-efficient computer at a time.

Believe it or not, the average desktop PC wastes nearly half the power delivered to it. Half! This wasted electricity unnecessarily increases the cost of powering a computer, and it also increases the emission of greenhouse gases.

Improving the energy efficiency of computers is a cost-effective way to reduce electricity consumption and the emission of greenhouse gases that contribute to climate change.

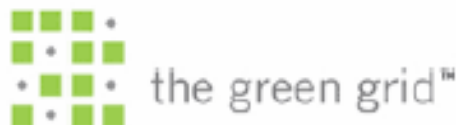
With your help, we can reduce global CO₂ emissions from the operation of computers by 54 million tons a year by 2010*. That's like taking 11 million cars off the road each year.

50%
REDUCTION

By 2010, we will achieve 50% reduction in power consumption per computer.¹

Contact Us
Questions
Suggestions
We're all in!

www.climatesaverscomputing.org



www.thegreengrid.com



DATA CENTER KNOWLEDGE

Phoenix
Full 42U Cab, A+B Pwr, Bandwidth
www.ioData.com
Ads by Google

ISO Certified hard drive and RAID data recovery services.

Ads by Google

[Atomic Data Centers](#)
Minneapolis-Phoenix-Atlanta Server Colocation & Hosted Solutions

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IBM Plans \$86M Big Green Data Center

IBM (NYSE: IBM) has announced plans for an \$86 million data center expansion that will add 80,000 square feet of technical space to its Boulder, Colo. facility. IBM will use the space to build a "green data center" featuring IBM's latest energy-efficient technology. The project is supported by a \$480



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HP plans data center consolidation

By Candace Lombardi
Staff Writer, CNET News.com



More Good News

- Utilities are involved:
 - SCE, PG&E, San Diego
 - CEE
- CA incentive programs are aggressive
- California Energy Commission, DOE, EPA all have data center initiatives



PG&E: Discussion points

- Why is PG&E helping customers to use less energy
- What is driving the emphasis on energy efficiency in the Information Technology/Data Center sector
- What programs and services has PG&E developed
- What strategies should we be taking to move towards “Green IT”
- Getting there: a leadership challenge.



PG&E: Discussion points

- What is driving the emphasis on energy efficiency in the Information Technology/Data Center/High Tech sector?
- What's happening on the ground with PG&E, leading high tech companies, and utilities across the nation.
- What are the likely developments in the near term.
- A challenge: Leadership



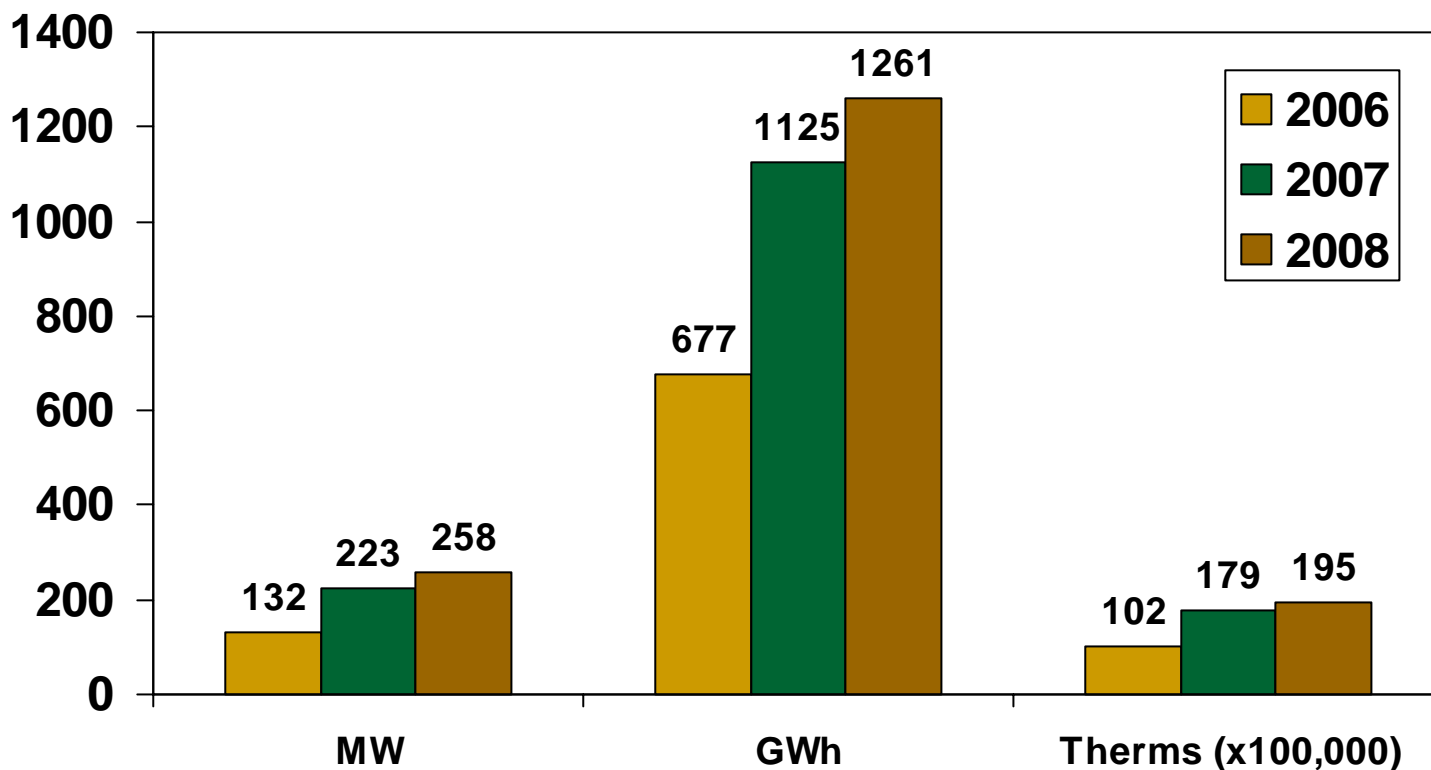
PG&E: Why energy efficiency?

- Our customers expect/love the programs
- All customers benefit through lower rates
- PG&E benefits financially
- Energy efficiency is the cornerstone of our commitment to environmental responsibility and quality



PG&E: Global-leading program

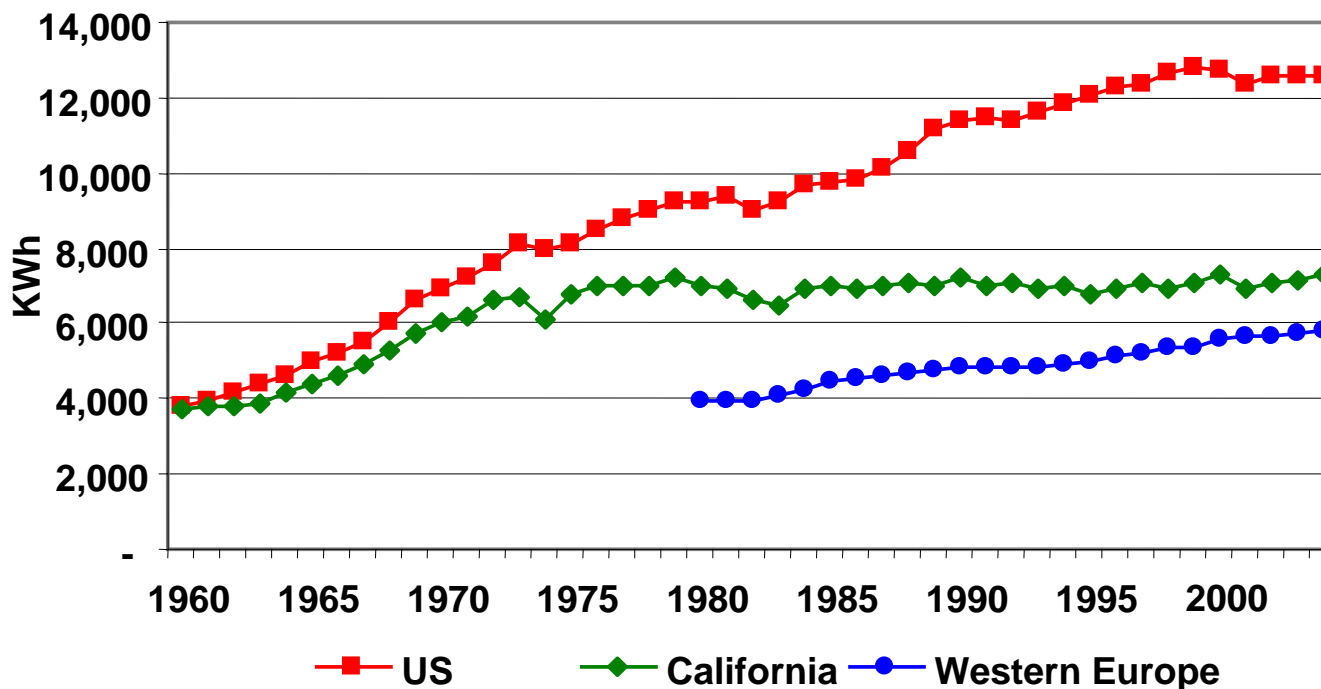
PG&E's Energy Efficiency Goals: 2006 through 2008





PG&E: 30 years of energy-efficiency success

- Energy efficiency programs have helped keep per capita electricity consumption in California flat over the past 30 years
- PG&E's programs alone have avoided the release of over 1 million tons of CO₂ into the atmosphere over the same period, equivalent to taking 8.6 million cars off the road for a year





PG&E's focus on high tech

- PG&E serves Silicon Valley – almost all of the industry heavyweights have a presence here
- They have their own facilities, and they are bringing solutions to energy challenges facing their customers
- The focus is on data centers and IT infrastructure



PG&E: Our direct market

- A total load of 400-500 MW (2.5% of total, compared to 1.2% nationally)
- “Enterprise” centers are known (stand-alone and co-location)
- “Corporate” centers are hidden in office buildings and campuses
- “Closets” are invisible
- The key challenge for enterprise and some corporate data centers is space, cooling, and power supply constraints, in the face of...



PG&E: Intense growth rates...

- IT workload growth is multiples of GDP for most companies, and can be 10x for some sectors (financial services, web businesses)
- All companies facing huge growth rates in data storage (50 to 100% annual growth not uncommon)
- When your back is up against the wall for IT capacity, you might consider...

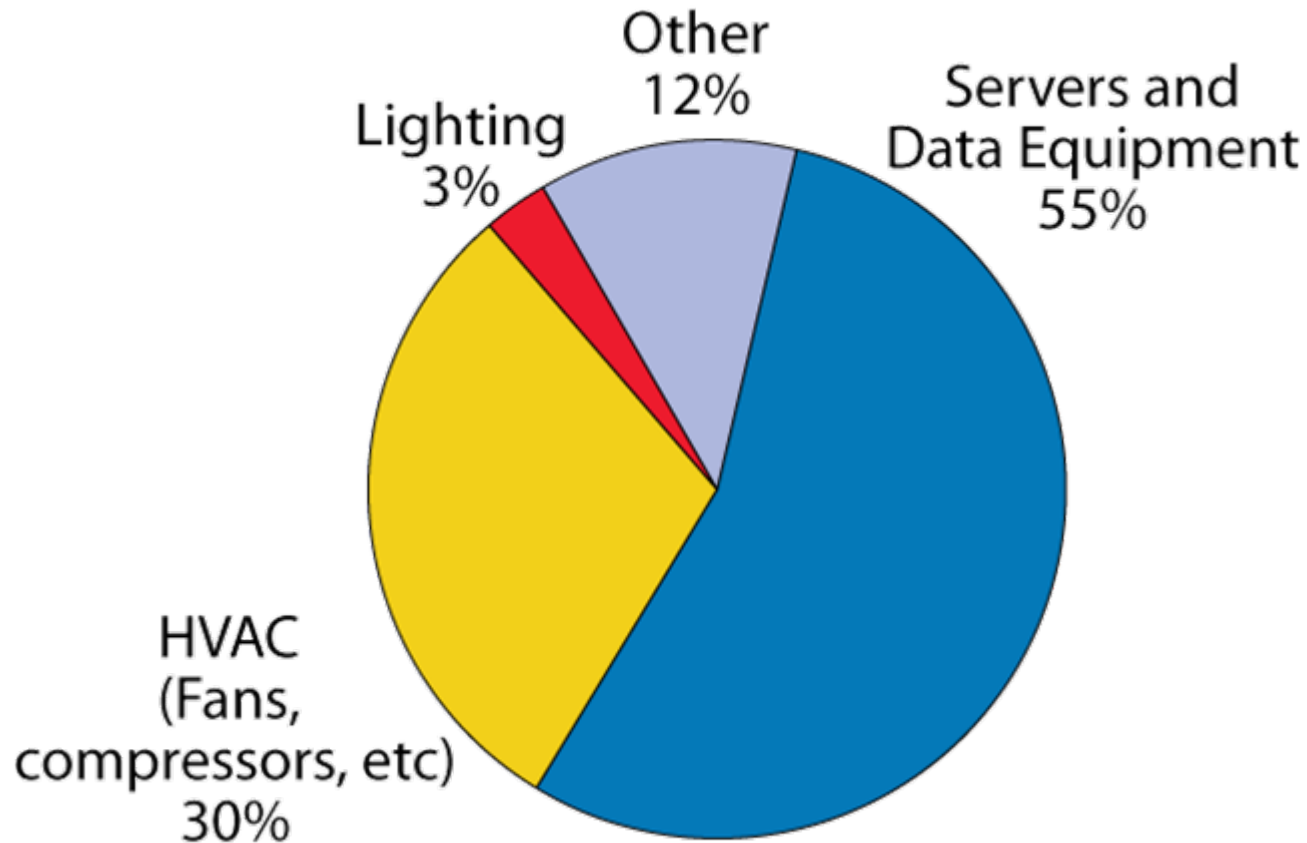


PG&E: Data center offerings pre-2006

- Audits, incentives that addressed cooling systems only:
 - High-efficiency equipment (chillers, pumps, fans, etc.)
 - VFD's
 - Air- and water-side economizers ("Free Cooling")
- What we were missing:
 - Anything having to do with operations "inside the white room"



PG&E: What we were missing



Energy use in a high-performance data center (LBNL/PG&E Study)



PG&E: New initiatives in 2006

- Incentives for energy-efficient computing equipment (Rip & Replace only)
- Incentives for virtualization/consolidation
- Incentives for airflow control systems
- Incentives for high efficiency UPS and power distribution systems
- High quality technical services for cooling system evaluation (retrofit and new construction)
- 80 Plus for personal computers (upstream incentive)
- Premium efficiency LCD monitors (midstream incentive)



PG&E: New/Coming in 2007

- Focus and incentives on efficient data storage technologies (just announced: MAID)
- Retro-commissioning program for airflow management
- Extension of 80+ program to data center computing equipment
- Rebates for PC management software (Now)
- Incentives for conversion to thin-client systems



PG&E: Initiatives in development

- Incentives for energy efficient servers (new installations)
- 80 Plus/CSCI program for computing equipment (servers, networking gear, storage systems)
- Rebates for virtualization/server consolidation
- Incentives/rebates for conversion to thin-client systems



PG&E: Results & utility industry leadership

- Industry agrees that a third to a half of data center energy use can be addressed through cost-effective, reliable energy efficient technologies and strategies
- PG&E achieves 4x of goals in 2007; looking for tens of MW of reduction per year starting in 2008
- PG&E announces formation Utility IT EE Coalition to extend program adoption across US and Canada



PG&E: Recommended strategies

- For CIOs and IT Operations:
 - Join Climate Savers Computing Initiative
 - Spec LCD monitors that exceed Energy Star standards
 - Consider thin client/desktop virtualization





PG&E: Recommended strategies

- For CIOs and IT Operations:
 - Begin or accelerate adoption of virtualization technology – consolidate server and storage equipment
 - Evaluate free cooling strategies for your data center
 - Institute airflow management best practices; raise supply air temperature; widen humidity set points



PG&E: Our challenge

- What does leadership in this market look like?
 - Data centers and IT operations that use multiple strategies to drive high efficiency
 - Equipment providers driving superior efficiency as well as performance
 - Utilities partnering with customers to provide solutions



PG&E: Predictions

- ▶ **Near term winners:**
 - ▶ Widespread adoption of Virtualization 1.0 for computing and data storage
 - ▶ Focus on efficient data storage technologies
 - ▶ Equipment metrics place high emphasis on efficiency as part of performance
 - ▶ Early adoption of Virtualization 2.0: IT load following and demand response.



PG&E: Predictions

- ▶ **Mid-term winners:**
 - ▶ Evolutionary power conditioning, management, and delivery systems
 - ▶ Virtualization 3.0: fully integrated, holistic data center power management
- ▶ **Long-term winners:**
 - ▶ Backup cooling systems, demand management
 - ▶ Truly “green” data center designs



PG&E: The Challenge

- ▶ What does leadership in “Green IT” for UC and CSU look like?
 - ▶ IT and facility operations staffs working together
 - ▶ A multi-pronged approach to drive energy efficiency
 - ▶ Leveraging funding opportunities like PG&E’s incentive programs



PG&E: Take Aways

- Utility customers can benefit from Incentive Programs
- Energy efficiency programs have kept California per capita electricity consumption flat over 30 years
- Utility efficiency goals continue to increase
- IT workload growth is high especially in research environments
- Data storage is high and growing
- Incentives in place for IT and infrastructure improvements for new or existing data centers
- New incentives are being added
- Industry agrees that 1/3-1/2 of energy use can be addressed
- IT and facility staff must work together to solve the problem



Take Aways

- IT equipment loads can be improved
- Air flow delivered by computer room air conditioners must satisfy IT equipment
- Different redundancy strategies have different efficiencies
- Operating within ASHRAE guidelines can save energy
- Modern IT equipment is not sensitive to humidity
- Isolating hot and cold can improve efficiency